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10 CFR 50.55a(z)(1)

1CAN082004

August 11, 2020

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Request for Relief related to American Society of Mechanical Engineers (ASME) Code Case N-770-5 Supplemental Examination Requirements ANO1-ISI-034

Arkansas Nuclear One, Unit 1
NRC Docket No. 50-313
Renewed Facility Operating License No. DPR-51

In accordance with 10 CFR 50.55a(z)(1), Entergy Operations, Inc. (Entergy) requests approval of the enclosed request for relief for the Arkansas Nuclear One, Unit 1 (ANO-1) high pressure injection (HPI) nozzle "D" dissimilar metal weld containing Alloy 82/182. Approval of this alternative request would permit the one-time extension of the volumetric examination frequency of Code Case N-770-5, Inspection Item B-1, as conditioned by 10 CFR 50.55a from the required frequency of "not to exceed seven years" to a proposed nominal frequency of 7.5 calendar years. The enclosure contains the affected component, applicable American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Case requirements, basis for request, and the proposed alternative.

Deterministic crack growth calculations bounding the potential for circumferential cracking in the subject weld at ANO-1 as well as required examinations and existing monitoring practices provide the basis for a one-time extension of the current volumetric examination frequency. Results of crack growth analyses demonstrate that structural integrity of the subject weld joints will be maintained under the proposed alternative reexamination frequency of a nominal 7.5 years and that use of this one-time extension will provide an acceptable level of quality and safety.

There are no new regulatory commitments included in this letter.

To allow sufficient time to complete the planning and having the required resources for the spring 2021 (1R29) refueling outage, Entergy requests approval of the proposed request by February 10, 2021.

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NRR

If there are any questions or if additional information is needed, please contact Riley Keele, Manager, Regulatory Assurance, at (479) 858-7826.

Respectfully,

Ron Gaston

RWG/rwc

Enclosure: Request for Relief – ANO1-ISI-034

Attachment to Enclosure:

1. Dominion Engineering, Inc., "Circumferential Crack Growth Evaluation for ANO-1 HPI Nozzle "D" Dissimilar Metal Weld," DEI Calculation C-4728-00-03, Rev. 0, dated August 4, 2020.

cc: NRC Region IV Regional Administrator
NRC Senior Resident Inspector – Arkansas Nuclear One
NRC Project Manager – Arkansas Nuclear One

Enclosure

1CAN082004

Request for Relief
ANO1-ISI-034

REQUEST FOR RELIEF
ANO1-ISI-034

Component / Number:	High Pressure Injection (HPI) Nozzle MU-45D nozzle-to-safe end weld
Code Classes:	American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Class 1
References:	ASME Section XI 2007 Edition through 2008 Addenda. ASME Section XI, Division 1, Code Case N-770-5, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated with UNS N06082 or UNS W86182 Weld Filler Material with or without Application of Listed Mitigation Activities"
Examination Category:	Table 1 of ASME Code Case N-770-5
Item Number(s)	B-1
Description:	Unmitigated butt weld at Cold Leg operating temperature (Code Case N-770-5. Section 2410) ≥ 525 °F (274 °C) and < 580 °F (304 °C), less than NPS 14 (DN 350)
Unit / Interval Applicability:	Arkansas Nuclear One, Unit 1 (ANO-1) / Fifth 10-Year Inservice Inspection (ISI) Interval (May 31, 2017 to May 30, 2027)

I. APPLICABLE REQUIREMENTS

The fifth 10-year ISI interval Code of Record for ANO-1 is the 2007 Edition through the 2008 Addenda of ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components."

Examinations of the HPI nozzle dissimilar metal welds are performed in accordance with ASME Code Case N-770-5, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated with UNS N06082 or UNS W86182 Weld Filler Material with or without Application of Listed Mitigation Activities," Section XI, Division 1 (Reference 1), as conditioned by 10 CFR 50.55a(g)(6)(ii)(F).

10 CFR 50.55a(g)(6)(ii)(F) requires, in part, that licensees of pressurized water reactors augment the inservice inspection program with ASME Code Case N-770-5 subject to the conditions specified in paragraphs (g)(6)(ii)(F)(2) through (16) of this section.

Table 1 of Code Case N-770-5 requires the following frequency of examination per Inspection Item B-1:

Visual: "Once per interval"

Volumetric: "Every second inspection period not to exceed 7 yr."

II. REQUEST FOR RELIEF

Entergy Operations, Inc. (Entergy) requests relief to extend the HPI nozzle "D" weld volumetric examination one operating cycle (approximately 18 months) to the fall of 2022 (i.e. refueling outage 1R30). If approved, the total requested interval from the time of the previous volumetric examination of this location would be 7.5 years. This HPI nozzle weld was last examined in spring 2015 (1R25) and is due for reexamination in spring 2021 (1R29), per NRC requirement 10 CFR 50.55a(g)(6)(ii)(F) and ASME Code Case N-770-5. The results of the 1R25 examinations identified no indications.

The requested extension would allow the next volumetric examination of HPI nozzle "D" weld to be performed during the same refueling outage as the next required volumetric examination of the other three HPI nozzle welds at ANO-1 (i.e., the dissimilar metal welds at HPI nozzles "A," "B," and "C"), which were last examined during the fall 2016 refueling outage (1R26) and are due for reexamination in fall 2022 (1R30). Performance of all four high pressure injection nozzle welds in such a coordinated manner would result in personnel dose savings for the site, promoting As Low As Reasonably Achievable (ALARA) practices associated with this significant non-destructive examination (NDE) activity, and minimizes the human performance challenges by allowing a more focused approach to work by performing the inspection in one outage versus two.

Analyses demonstrate that the proposed one-time alternative reexamination frequency of a nominal 7.5 years will maintain an acceptable level of quality and safety.

III. BASIS FOR RELIEF

The Alloy 82/182 dissimilar metal piping butt welds joining each HPI nozzle and safe end are located in the cold leg temperature region of the reactor coolant system (RCS). As operating at cold leg temperature has a large benefit compared to an Alloy 82/182 weld operating at hot leg or pressurizer temperatures, the subject weld has a substantially reduced susceptibility to primary water stress corrosion cracking (PWSCC).

As discussed below, conservative deterministic crack growth calculations performed specific to the subject weld at ANO-1, along with other required examinations and existing monitoring practices, constitute the basis for extension of the current volumetric examination frequency for the subject welds. The technical basis provided below demonstrates that the one-time alternative reexamination frequency will maintain an acceptable level of quality and safety.

Cold Leg Alloy 82/182 Dissimilar Metal Butt Weld Operating Experience

A relatively small number of cases have been reported of PWSCC affecting relatively small diameter (Nominal Pipe Size (NPS) 3 inch and smaller) Alloy 82/182 piping butt welds at cold leg branch connections. PWSCC has also been detected in other Alloy 600/82/182 components exposed to cold leg temperatures, including control rod drive mechanism (CRDM) nozzles, reactor vessel bottom mounted nozzles, and steam generator tubing. Therefore, the subject weld is susceptible to PWSCC, and axial and circumferential PWSCC flaws are postulated in the assessment below.

Plant-Specific Circumferential Crack Growth Evaluation

Crack growth calculations were performed considering the specific geometry and loads applicable to ANO-1 HPI nozzle "D", including plant-specific weld residual stress (WRS) analysis results. These calculations, which are documented in Attachment 1 to this Enclosure, applied the common deterministic approach for unmitigated Alloy 82/182 piping butt welds in pressurized water reactors (PWRs) to model growth of circumferential cracks due to PWSCC. The results of these crack growth calculations demonstrate the acceptability of the nominal 7.5-year alternative volumetric reexamination intervals for the ANO-1 HPI nozzle "D" by demonstrating that this alternative volumetric examination frequency is sufficient to provide reasonable assurance of the structural integrity of the HPI nozzle at ANO-1. Hence, this alternative frequency provides an acceptable level of quality and safety.

The limiting case for the calculated time for a circumferential crack to grow from 10% through-wall to the maximum allowable size is 14.6 years, which is almost twice the nominal 7.5-year alternative volumetric reexamination interval. The limiting case is for a circumferential crack growing to an allowable depth of 75% through-wall. In this limiting case, an additional 1.2 years is calculated for the circumferential crack to penetrate through the remaining 25% of the wall thickness. The crack growth time result of 14.6 years conservatively reflects an initial total-length-to-depth aspect ratio of 10. The initial depth of 10% through-wall is the standard assumption for an initial flaw that is reliably detectable in the volumetric examination required by Code Case N-770-5 (Reference 1).

This limiting case includes the weld residual stresses from a 90° partial-arc 70% through-wall localized weld repair performed from the outside diameter (OD). This conservative weld repair assumption was developed on the basis of a review of fabrication records for the original dissimilar metal weld and the dissimilar metal weld performed during replacement of the safe end in 1982. The modeling approach recommended in MRP-287 (Reference 2) includes consideration of weld repairs, even if no documented repairs have been identified, as is the case for this weld. Given the length of the safe end (5-1/8 inches), the relatively small inside diameter at the subject weld (2.0 inches) makes weld repair from the inside of the weld infeasible. The use of a backing ring to make the weld joint demonstrates that all welding was performed from the outer surface of the joint. Hence, the 90° partial-arc repair extending about 70% of the distance from the outer surface was developed as a conservative weld repair assumption, with the worst-case stress profile from the three-dimensional WRS modeling applied in the crack growth evaluation. A partial arc repair type generates tensile residual stresses at the inside diameter (ID) that are consistent with a hypothetical crack initiation at the ID surface. This conservative approach was applied in lieu of the assumption of a 50% through-wall ID repair recommended in MRP-287 (Reference 2) because of the infeasibility of ID repair in this specific case.

The circumferential crack growth evaluation applies the PWSCC growth rate equation for Alloy 182 weld metal incorporated within Nonmandatory Appendix C of ASME Section XI. The equation was incorporated into the 2010 Edition of Section XI, which is incorporated by reference within 10 CFR 50.55a. Furthermore, a universal weight function method was applied to accurately calculate the stress intensity factor resulting from the through-wall stress distribution. This approach does not fit a polynomial to approximate the stress profile, as is often the case when applying published solutions such as the method of influence coefficients. Fitting the stress profile to a polynomial can introduce a significant source of modeling uncertainty depending on the accuracy of the fit obtained. The worst-case stress profile from the three-dimensional WRS calculation is conservatively assumed to apply to the entire crack front.

Structural Integrity

Axial cracks affecting the subject weld are not a credible concern for producing a pipe rupture and loss-of-coolant-accident. The critical length of an axial flaw needed to cause unstable rupture is much greater than the axial width of Alloy 82/182 weld metal susceptible to PWSCC. For the HPI nozzle "D" Alloy 82/182 weld, the width (i.e., axial extent) of Alloy 82/182 weld metal is nominally 1.1 inches. Therefore, structural integrity under the proposed alternative reexamination frequency of a nominal 7.5 years will be maintained. The circumferential crack growth evaluation shows that any circumferential cracking would not extend beyond the allowable size per ASME Section XI during the alternative volumetric reexamination interval. As stated, axial flaws do not present a credible rupture concern regardless of the reexamination interval.

Leak Tightness Considerations and Maintenance of Defense in Depth

Unlike the case for circumferential cracking, corresponding crack growth results for axial flaws would show the potential for leakage to occur for the subject weld if axial PWSCC is postulated under both the N-770-5 (Reference 1) and alternative volumetric reexamination frequencies. The frequent visual examinations performed from the exterior of the welds, in accordance with ASME Section XI (i.e., VT-2 during system pressure testing) and ASME Code Cases N-770-5 (Reference 1) and N-722-1 (Reference 4), provide defense-in-depth to address the possibility of through-wall axial cracking and consequent boric acid corrosion. Additionally, Entergy trends daily RCS leak rate values in accordance with procedures consistent with the guidance of WCAP-16465-NP (Reference 3). These guidelines for enhanced leak rate monitoring would require a response in the case where the seven-day rolling average of daily RCS unidentified leak rates exceeded 0.1 gpm. Finally, the additional risk of leakage occurring under the proposed frequency is relatively small as the alternative nominal volumetric reexamination frequency represents only about a 7% increase over the maximum interval permitted by N-770-5 (7.5 versus 7 years). The visual examinations for leakage and enhanced leak rate monitoring are concluded to maintain defense-in-depth and address the concern for leakage occurring due to postulated axially oriented PWSCC.

Conclusions

In summary, conservative deterministic crack growth calculations specific to the subject weld for ANO-1, along with other required examinations and existing monitoring practices, constitute the basis for a one-time extension of the current volumetric examination frequency for the subject weld. The alternative frequency for the subject weld would allow alignment of the timing of the

volumetric examination with that for the other three HPI nozzle welds, resulting in reduced overall dose to personnel and minimizes the human performance challenges by allowing a more focused approach to work by performing the inspection in one outage versus two. The evaluation of circumferential flaws demonstrates that structural integrity is maintained by showing that the time for growth from a flaw with detectable depth to a flaw size at the limit of acceptability per ASME Section XI is much longer than the requested frequency. Axial PWSCC flaws at the subject welds do not represent a credible concern for unstable rupture, while other required examinations and existing monitoring practices address the concern for axial cracking affecting leak tightness. Defense-in-depth is maintained through the frequent visual examinations for evidence of leakage in combination with enhanced online leak detection capabilities.

These analyses demonstrate that the alternative reexamination frequency of a nominal 7.5 years will maintain an acceptable level of quality and safety. Therefore, Entergy requests that the NRC authorize this proposed alternative in accordance with 10 CFR 50.55a(z)(1).

IV. PROPOSED ALTERNATIVE INSPECTIONS

No alternative examination is proposed at this time. Entergy has examined the subject weld visually for evidence of pressure boundary leakage as required by ASME Code Cases N-770-2 and N-722-1 (Reference 4), and Entergy will continue to perform pressure testing on the subject components as required by the ASME Section XI Code.

V. PRECEDENT

On March 24, 2020, NRC (ML20080K508) approved a similar relief request (ML19275D252) for the unmitigated Reactor Coolant Pump nozzle Alloy 82/182 piping butt welds at Millstone Unit 2. That relief request proposed an extended interval between volumetric examinations of the unmitigated Alloy 82/182 piping butt welds on the basis of crack growth evaluation results for circumferential flaws, with the potential for leakage due to axial cracking addressed through defense-in-depth considerations.

V. CONCLUSION

From 10 CFR 50.55a

> (z) Alternatives to codes and standards requirements. Alternatives to the requirements of paragraphs (b) through (h) of this section or portions thereof may be used when authorized by the Director, Office of Nuclear Reactor Regulation, or Director, Office of New Reactors, as appropriate. A proposed alternative must be submitted and authorized prior to implementation. The applicant or licensee must demonstrate that:
>
> (1) *Acceptable level of quality and safety.* The proposed alternative would provide an acceptable level of quality and safety; or
>
> (2) *Hardship without a compensating increase in quality and safety.* Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Based on foregoing discussion, Entergy has determined that the conditions of 10 CFR 50.55a(z)(1) are met in that the reexamination interval can be extended from 7 years as required by Code Case N-770-5 to the requested interval length of 7.5 years while maintaining an acceptable level of quality and safety.

VI. REFERENCES

1. ASME Code Case N-770-5, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated with UNS N06082 or UNS W86182 Weld Filler Material with or without Application of Listed Mitigation Activities," Section XI, Division 1, American Society of Mechanical Engineers, New York, Approval Date: November 7, 2016.

2. "Materials Reliability Program: Primary Water Stress Corrosion Cracking (PWSCC) Flaw Evaluation Guidance (MRP-287)," EPRI, Palo Alto, CA: 2010. 1021023.

3. "Pressurized Water Reactor Owners Group Standard RCS Leakage Action Levels and Responses Guidelines for Pressurized Water Reactors," WCAP-16465-NP Revision 0, (ML070310082), dated September 2006.

4. ASME Code Case N-722-1, "Additional Examinations for PWR Pressure Retaining Welds in Class 1 Components Fabricated with Alloy 600/82/182 Materials," Section XI, Division 1, American Society of Mechanical Engineers, New York, Approval Date: January 26, 2009.

ATTACHMENT

1. Dominion Engineering, Inc., "Circumferential Crack Growth Evaluation for ANO-1 HPI Nozzle "D" Dissimilar Metal Weld," DEI Calculation C-4728-00-03, Rev. 0, dated August 4, 2020.